PKP Prozessmesstechnik GmbH

Borsigstrasse 24

D-65205 Wiesbaden-Nordenstadt

Tel: 06122 / 7055 - 0

Fax: 06122 / 7055 – 50

Operating Instructions

DB04

Thermal mass flowmeter for gases without auxiliary power

Table of Contents

01 Welcome

With DB04 you get the latest, most modern CMOS sensor technology. CMOSens™ is a technology label and stands for a modern process in which the sensor and the signal processing are combined on a highly integrated chip.

This manual will familiarize you with the installation and operation of your DB04. We therefore ask you to read this manual carefully and to contact your sales partner with any questions or doubts.

We have prepared this manual very carefully in order provide you with appropriate and precise information and instructions. However, no liability is assumed for any errors.

Operator Benefits

Ultimately, a technology only represents a means to an end. Therefore all of our efforts are aimed at the requirements and wishes of the user of this instrument and his measurement and regulation tasks:

- *Battery-operated thermal mass flow meters*
- *Optional alarm function*
- *Compact, easy-to-install measurement or regulation unit*
- *CE approved*
- *Easy maintenance and service*
- *Easy expansion of functionality*
- *3-year guarantee*
- *Top performance in response, dynamics and accuracy*
- *Matching options and accessories*

Service and quality

We continuously improve the quality of our products and services. Only with use does it ultimately become clear whether the right product has been selected. Thus, we attempt not only to propagate good service and high quality, but to live it every day.

Guarantee

The guarantee for DB04 *for gasflow* products extends to material defects and production flaws. The guarantee maximum is the replacement of the equipment at no cost. Claims are omitted in the case of inappropriate use, external effects in general, excessive heat or dropping.

We are always grateful for information on existing defects, for suggestions for improvements, and for critiques.

Tips and Warnings

Before putting the instrument into use, these operating instructions should be read thoroughly. Improper use, errors for lack of understanding and the consequences arising from this, can lead to the destruction of the instrument or even the endangerment of personnel.

The equipment should be put into operation and serviced by appropriately qualified personnel only. The proper handling of the products is an absolute requirement for its trouble-free operation.

Electrostatic discharges can destroy the electronic components of this measurement and regulation unit.

02 A bit of theory

Measuring principle

The measuring principle of thermal flow measurement is perfectly suited for the measurement of gas flows. One of the significant advantages is that the measurement is largely independent of pressure and temperature. By contrast to volumetric principles, pressure and temperature do not have to be additionally measured. Although the principle yields mass as a measurement result (e.g. g/min), most devices are calibrated to standard volumes (e.g. ln/min). One possible explanation is the fact that the comparability of the measurement results with other principles is given with this. Since the thermal flow measurement depends on the type of gas, in addition to the specific heat , the standard density (0°C, 1,01325 bar a) for the conversion to standard volume is also used.

With all design options of the measuring principle, there is always a heater and one or more temperature-measurement points and the gasflow draws heat from the heater.

With the mass flow meter, a constant heating power ensures a temperature difference that is directly proportional to the gas flow rate. In the flume, a temperature measurement is followed by a heater, and then a temperature measurement again. The figure below illustrates this process. If the flow rate=0, the heater H uniformly distributes the heat, for which the temperature difference T1-T2 equals zero. Two effects occur with the flow rate that lead to a temperature difference: First, the temperature sensor T1 at the entrance detects a lower temperature. This happens because of the cooling of the entering gas, which theoretically drops to the ambient temperature respective of gas. Secondly, the gas flowing over the heater carries heat to the temperature sensor T2, located after the heater, and thus increases this temperature. The temperature difference is in direct proportion to the mass flow.

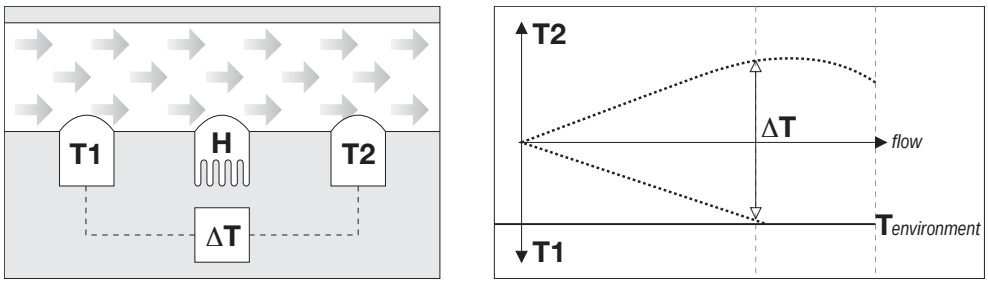


Figure 2: Schematic illustration of how thermal mass measurement functions

CMOS Technology

DB04 measurement and regulation units feature a new basic technology that sets standards for maximum precision sensor systems. The fusion of a semi-conductor chip with sensor technology results in a highly integrated system solution that is impressive for its excellent sensor precision, as well as digital intelligence and reliability.

The most notable advantages to the customer are the outstanding precision of the sensor, the rapid response time and a dynamic measuring range that no system has attained up until now.
Thanks to the compact single chip design, CMOSens™-based sensors are extremely resistant to electromagnetic interference (EMI), a significant technical advantage of this ultra modern sensor technology.

With CMOSens™, the sensor element, amplifier and A/D converter form a unit on the same silicon chip.

The digital intelligence linked with the CMOSens™ sensor permits the emission of a fully calibrated, temperature-compensated output signal. The CMOSens™ 'intelligence' integrated onto the chip thus facilitates an extremely simple processing of the emitted measurement data. CMOS is a standard technology for the manufacture of integrated circuits.

CMOS chips are generally known as 'semi-conductor chips', 'silicon chips' or 'computer chips'. They are widely used in PCs, mobile telephones and many other information technology devices.

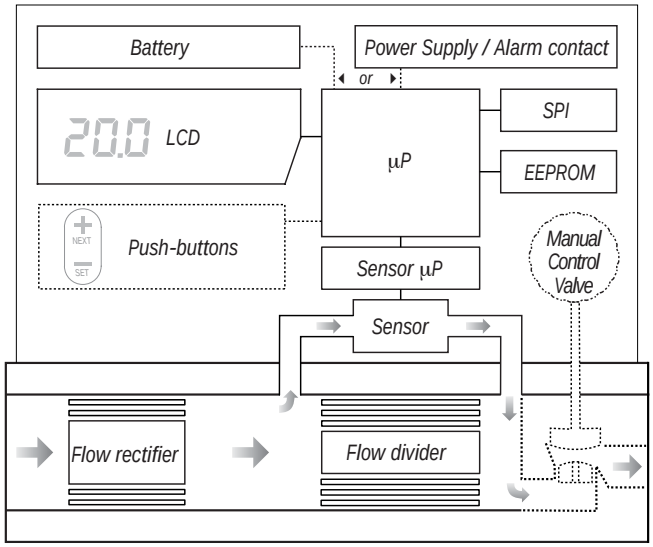


Figure 2: Block diagram of the hardware

03 Technical Information

General Specifications of the Device

Accuracy	+/- 1% of full scale
Dynamics	
Standard measurement range	2 – 100 % within the specification Signal suppression less than 2% of full scale
Repeatability	+/- 1% from measurement value
Long-term stability	< 1% from measurement value / year
Temperature coefficient	-
Pressure coefficient	< 0,2% / bar (typical N2)
Operating pressure	up to 10 bar g
Temperature range	0 – 50 °C
Leak rate	1 x 10^{-8} mbars l/s He
Heat-up period	30 minutes for maximum accuracy

Mechanical specifications

Materials	
Design Code A (Alu)	Aluminum, nickelized brass, stainless steel
Design Code E (high-grade steel)	Stainless steel
Sensor	PBT, epoxy
Sealing material	FKM, optional EPDM or PTFE
Process connection	Inside thread G1/4", G1/2" on both sides, optional with compression fittings (see accessory annex)
Protection category	IP-50, front side IP-65

Electrical data

Supply voltage	
Battery operation	With battery module, useful life ca. 2 years
External feed	+ 24 V dc +/- 10%
Alarm contact (switch and all-in)	
Function	Floating change-over contact
Max voltage	24 Vdc
Max current	1 A

Display

LC Display	For present flow rate with bar graph and the corresponding unit. Configuration parameters for the alarm function

Measurement Ranges

DB04 measurement and control devices are supplied with standard measurement ranges for air. As an option, the devices are available with individual measurement ranges and, upon request, can be calibrated with other gases.

Standard Measurement Ranges

Meas. range	*Unit*	*Meas. range*	*Unit*
200	mln/min	20	ln/min
500	mln/min	50	ln/min
2000	mln/min	100	ln/min
5000	mln/min	200	ln/min

Connector Assignment

Instruments with the switch or external power supply are fitted with a cable (2m length) with the following assignment:

Color	*Assignment*	*Color*	*Assignment*
white	+ 24 Vdc	grey	AL1 normal open
brown	0 Vdc	pink	not assigned
grenn	AL1 common	blue	not assigned
yellow	AL 1 normal closed	red	not assigned

Conversion Factors for other Gases

Every instrument is fully and automatically calibrated on an ultra modern calibration system. The internal conversion to the defined medium is done according to the application. Should you change the mass medium, this may be corrected via conversion factors.
For this, contact your sales partner. Depending on the medium, these conversion factors generate an additional measurement error.

Note

In the case of plant calibration with a gas other than air, an increased zero offset may be displayed when the device is not operated with the calibrated gas.

Pressure Loss

The thermal mass flow meters feature little pressure loss. This essentially depends upon the medium, operating pressure and the flow rate. In the annex (chapter 08/page 19) you will find a table that shows the typical course of pressure loss in air, 20°C, 1,013 bar a for the three measurement devices. The pressure loss for other gases can be calculated using the formula.

$$\Delta P_{required} = \Delta P \times \sqrt{\frac{\rho_{required}}{1.250}}$$

Please note that pipes that are two small and unsuitable fittings are often the cause of excessive pressure loss in the system.

For trouble-free operation, devices with manual control valve require a certain pressure differential, which is specified on the nameplate.

Temperature Compensation

Thermal mass flow meters measure the flow of gases to a large extent independent on pressure and temperature. Varying temperatures are automatically compensated by the measurement device. The sensor measures gas temperature and automatically calculates a correction value using a three-dimensional value table.

Pressure Compensation

With the calibration, the operating pressure specified with the order is also taken into consideration. With pressure changes, an additional error can occur. Please note that the operation of the manual control valve cannot be guaranteed if the pressure differential is too low or too high.

04 Mounting & Installation

General Tips

Check the packet for external damage and contact us immediately in the case of visible damage. Compare the contents of the packet with the delivery slip and check for completeness and technical compliance.
This product is a high-precision measuring instrument. We advise you to select the installation site carefully and to follow the instructions and suggestions below.
Before installation, be sure that the data on the nameplate corresponds to the use, and that the maximum pressure occurring in the system are lower than the specified test pressure of the device.

Installation Position/Location

We recommend a horizontal installation position. With higher pressure(> 5 bars), depending on the medium, an additional offset error can occur with a vertical installation position. Check that no heat sources or electrical sources with strong emissions are found near the measuring device. Avoid constant vibrations or other disturbing mechanical effects (stress).
If there is a risk of fluid backflow during malfunction, then you should not mount the measuring device at the lowest point of the pipe.

Mechanical Pipes

The pipe work is very important, and this is often underestimated. Inlet paths, dead volume of the correct amount, proper grounding, clean pipes and leak-free connections have a decisive effect on the quality of the measurement.

Be sure that the piping used is absolutely clean.

Use suitable pipe materials (compressive strength, durability).

With permanent pipes, it is also recommended that the device be fixed with the mounting holes provided for this.

Avoid, when possible, a 90° angle directly at the inlet. If there is no other possibility, consult your sales partner.

Use appropriate fittings, which are preferably sealed with o-rings on the front side against the body of the device. Please do not hold on the housing while tightening the fittings.

Never use liquid sealant! If it has not hardened, it can spread all through the measuring device during flow.

Optimize the pipe length between pressure reducing unit and flow meter. A certain dead volume must be available with high flow rates in particular. The pipe diameter must likewise be adapted to the flow rate. Pipe sections that are too small cause high pressure loss and can impair the operation of the device.

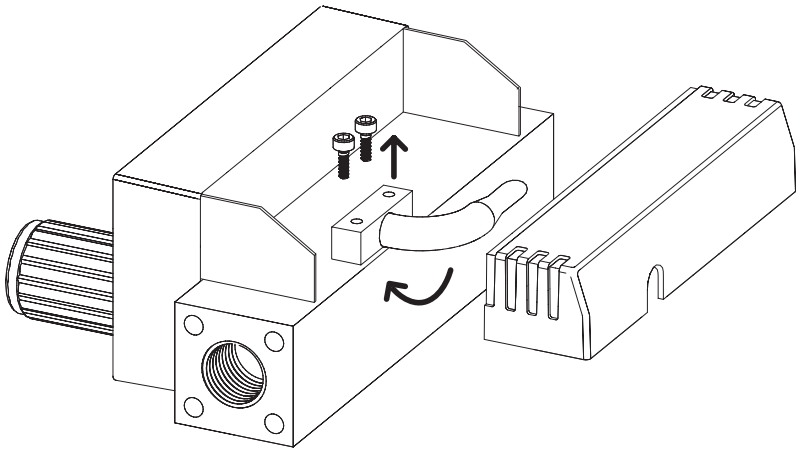
Check the piping for any leaks.

The measuring devices have a flow rectifier. Nevertheless, with high flow rates (> 50 ln/min), we recommend that you install an inlet path (10 times pipe diameter).

With critical applications (e.g. consumption metering with gas supply), we recommend the installation of a bypass system with which you can continue to draw gas in the case of service or repairs.

Electrical Connection / Power Supply

With the battery-operated devices, mount the battery module. Then the measuring device is ready for use. The useful life of the battery module is about 2 years, but this depends on use. With constantly changing flow rates, the useful life may be shorter. We advise you to use only original battery modules.
With the external power supply and alarm options, you receive a connector cable with loose ends. The assignment is printed on the cable. You have the option of turning the cable outlet by 180º. To do this, you open the cover in back by hand and turn the plastic block to the desired direction.



Turning the cable outlet by 180°

The supply voltage must be + 24 Vdc (+/-10%) and have the lowest possible residual ripple. Please note that voltage drops may occur with longer connecting cables.

Likewise, be aware of possible earth loops when you ground electrically conductive pipes.

Gas Supply

We recommend that you pay close attention to the gas supply line. Contamination in the form of water, oil or dust are harmful to any measurement principle. Particularly in the case of air supply with compressor systems, cleanliness cannot always be guaranteed. In case of doubt, install the appropriate filter. If use-related backflows are to be expected, this filter should also be installed at the outlet. Please monitor possible pressure loss due to the filter elements.
The gas supply should be oversized and have the capacity of at least twice the flow rate of the attached measuring device. Monitor the performance of the pressure-reducing unit, as well. Never install the pressure regulator directly in front of the measuring device.
Check for possible pressure loss along the pipeline system. Flow regulators especially require defined pressure ratios for proper functioning.
With very low flow rates, pressure reduction is oversized and gas is only periodically fed (on-off regulation). This becomes evident in the form of periodic fluctuations in the regulation or changes in the flow rate.
Avoid abrupt pressure buildup in the system. This can lead to damage.
Charge the system with pressure only after establishing the electrical connections.
Be sure to have an inert gas (e.g. nitrogen) available for flushing in the case of dangerous, abrasive or corrosive gases.

05 Operation & Service

Heat-Up Time

Right when the device is turned on, it is ready for use. For the most precise measurements, however, it is ready in 30 minutes (option of external feed). Before turning on,please be sure that the wiring is correct and is installed according to the installation plan, and that the gas connections are also mounted in accordance with the installation instructions of the manufacturer.

Zero Point Check

Without any special specifications for the installation position of the device, the zero point is aligned at operating temperature and horizontal installation position before delivery. If the device is installed vertically, a value can be read out at a zero flow rate according to operating pressure. During the check, be completely sure that no gas is flowing. In the case of a shift in the zero point, please contact your sales partner.

Service

With proper operation,DB04 does not require any routine service at all. If the measurement value is in a quality-relevant range (e.g. ISO 9001), we recommend a periodic check of calibration. The interval depends strongly on use.

Cleaning in the Case of Contamination

Should there be suspicion of contamination (sudden deviation of measurement value in familiar processes, visible traces in the piping, etc.), try flushing the device with a dry inert gas. Depending on the contamination, it may be necessary to dismantle the device.

Tips

- *Use only designated tools.*
- *Handle the device and individual components with extreme care.*
- *Ensure that the dismantling area is clean.*
- *The guarantee lapses at all events with the dismantling of the device.*
- *Never loosen a torx screw.*
- *Do not touch the electronic circuit board or electronic components under any circumstances.*
- *After the cleaning, you should have the device checked by your sales partner at the first opportunity.*

Dismantling Flow Module

- Disconnect the gas and electrical connections.
- On the inlet side, carefully unscrew the flow rectifier together with the flow divider. With this design, there are no o-rings in this area. You can now clean the entire flow module with a mild solution (e.g. IPA). Afterwards, ensure that the bored holes are absolutely clean, dry and cleared.

Battery Replacement

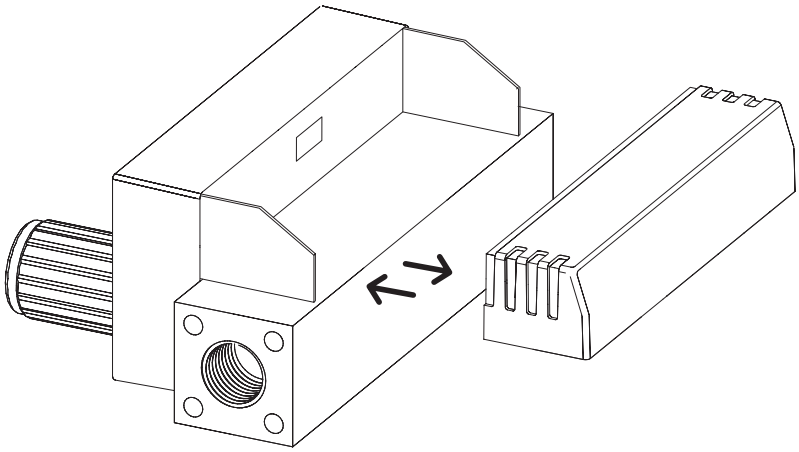
If 'low bat' appears in the display, we recommend that you change the battery or at least have a new battery module

We recommend the following procedure with the replacement of the battery:

Changing the battery requires no tools at all. The battery module snaps into two lateral housing clips. Hold the measuring device firmly with one hand on the main body (metallic part) and pull the battery module out toward the back, keeping it as level as possible.

Then, place the new module in as straight as possible from the back, and press in the direction of the measuring device until it snaps into the clips.

After the battery is changed, the device goes through a self-test and is then ready for use.



Replacement of battery module

Returns

With the return of a measurement or regulation device, use the original packaging if possible, or other appropriate packing. Please inform us of the reason for the return in order to spare any unnecessary callbacks and delays.

Should the device come in contact with dangerous substances, please clean the device carefully, notify us and pack the device tightly.

If you have any further questions, please contact your sales partner.

06 Alarm & Switch Function

Individual Functions in Detail

Resetting the Alarm Condition AL clr

In the case of alarm condition, the alarm can be reset. This is only possible if the manual option is selected in the corresponding menu (resetting the alarm AL rES). The alarm condition is shown in the display.

Setting the Alarm Setpoint ALSEtP

The desired threshold can be set with the +/- keys. This value can be between 0 and the maximum possible measurement value. The threshold unit corresponds to the measurement value.

Alarm Functions ALFUnc

Measurement values greater (AL hi) or lower (AL Lo) than the threshold value that are considered an alarm condition can be defined. In addition, the alerter function can be deactivated (AL oFF).

Failsafe Mode FA ILSA

If this function is activated, the switching logic of the outlet is operated in such a way that alarm conditions, as well as device failure and line break can be detected. In the examples, you will find the switching manner of the contact in the case of activated function.

Setting the Alarm Delay Time dELAY

An adjustable time of 0 – 180 sec., during which the alarm condition should last until the alarm contact is appropriately activated. If the upper or lower threshold is surpassed, the triggering of the alarm is prevented.

Setting the Alarm Hysteresis hYSt

Should the momentary flow rate and the established threshold be close to one another, setting the hysteresis prevents the alarm from constantly going on and off. The value can be from 0 to 10% of the maximum possible target value.

Setting the Low Alarm Suppression LoSUPr

If a minimum alarm (AL Lo) is configured, and if the flow rate is at zero from the start, this triggers the alarm immediately. With the 'low suppression' function, this can be avoided. Here, the alerter function is only activated if the flow rate is over the threshold.

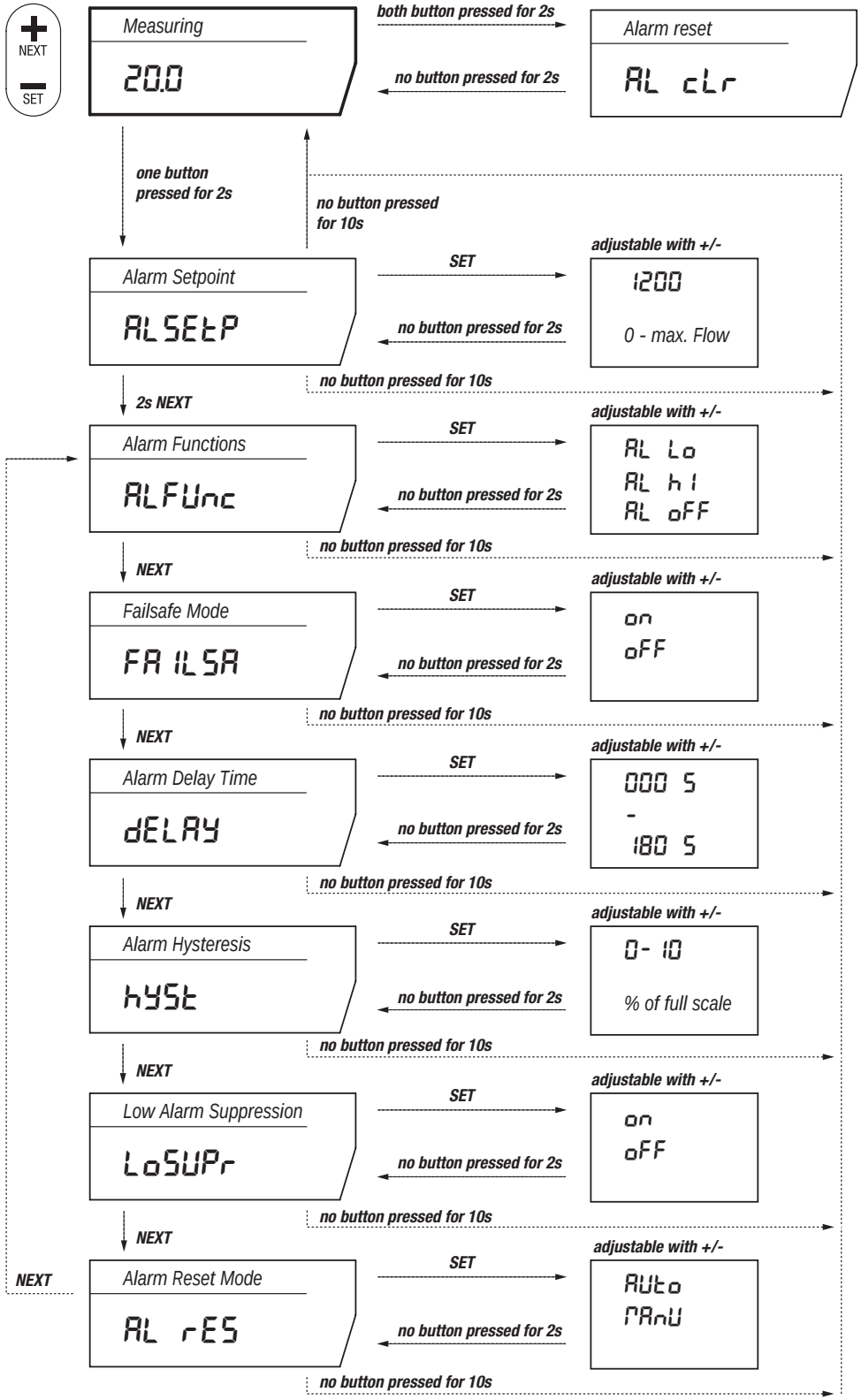
Alarm Reset Mode AL rES

There are two options:

Auto: *The alarm automatically resets after the flow rate returned to normal condition.*

Manu: *Manual reset with the function AL clr.*

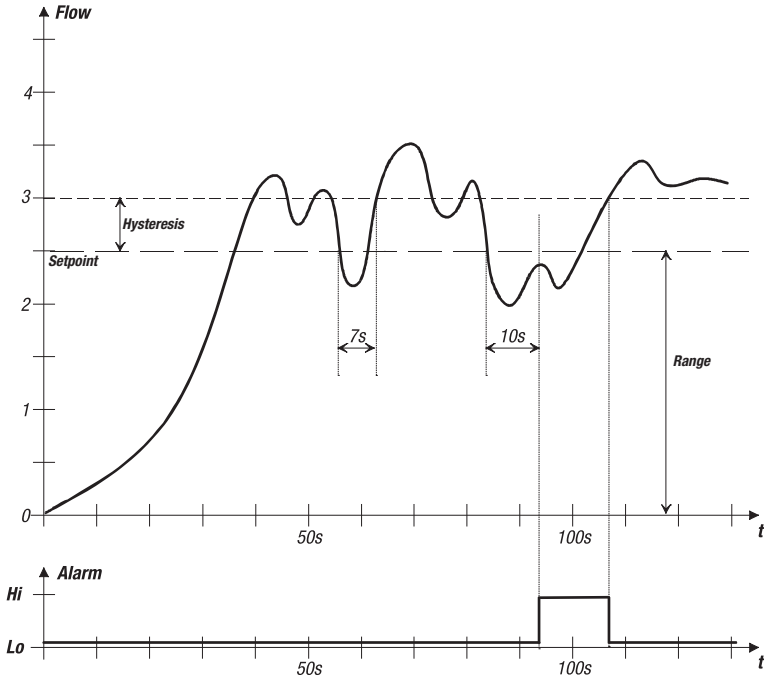
Diagram of Function Settings



Alarm situations

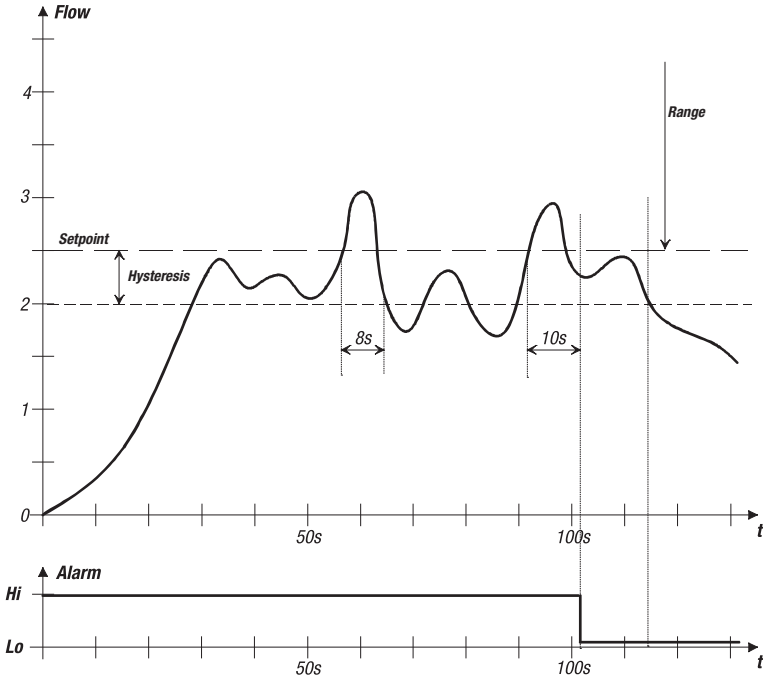
Situation 1 / Parameters:

Function	Value	Function	Value	Function	Value
ALSEtP	2.5	DELAY	10s	AL rES	AUto
ALFUNC	AL LO	HYST	0.5		
FAILSA	Off	LoSUPr	On		



Situation 2 / Parameters:

Function	Value	Function	Value	Function	Value
ALSEtP	2.5	DELAY	10s	AL rES	MAnu
ALFUNC	AL HI	HYST	0.5		
FAILSA	On	LoSUPr	OFF		



07 Totalizer

General

The Totalizer function can be activated by the ***manufacturer***.

Function

The instrument calculates the integrated value of the gas volume. The added up value is periodically displayed and stored in intervals of 15 minutes in the non-volatile storage (EPROM). In the event of a power disruption, the Totalizer therefore displays the correct total volume. It is, however, possible that the gas volume for the past 15 minutes may be lost.

The added-up volume of the Totalizer and the flow value are alternatively displayed.
The display intervals are adjusted by the manufacturer as follows:

Flow: *5s*
Total: *3s*

The unit of the Totalizer volume is adjusted by the ***manufacturer***.

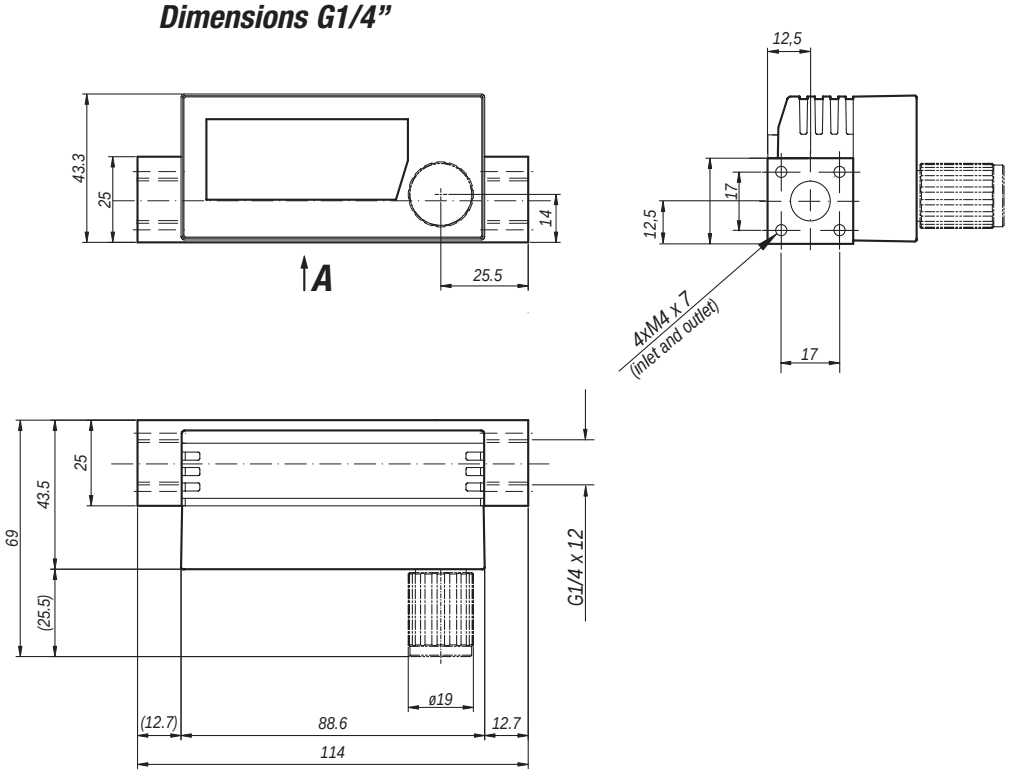
Reset

The Totalizer function can be activated by the manufacturer in two different modes:

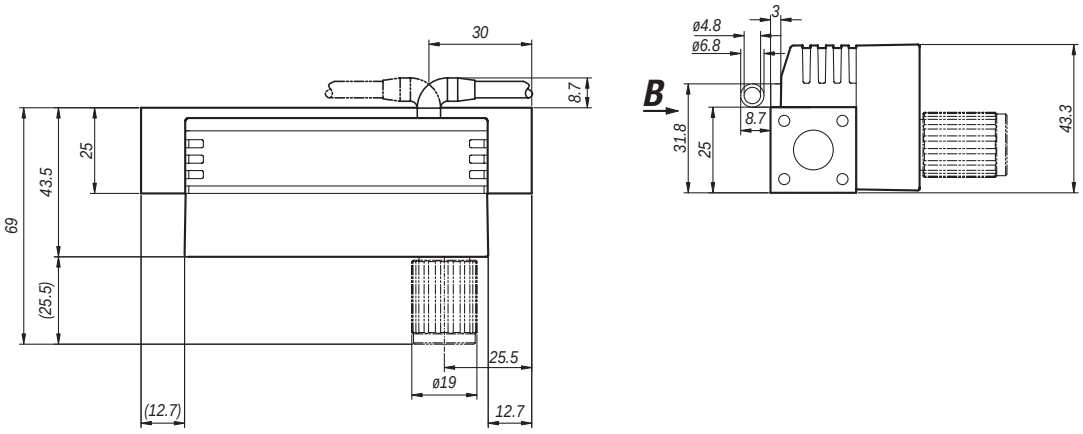
1. *Totalizer without reset*
   In the event of a power disruption the most recently registered value from the non-volatile storage (EEPROM) is loaded and added up further.
2. *Totalizer with reset*
   In the event of a power disruption, the Totalizer volume is set to zero and from then on resumes adding-up.

08 Dimensions

Dimensions G1/4”

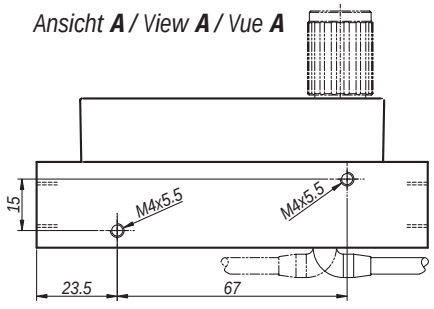


Mit externer Speisung / With external power supply / Avec alimentation externe

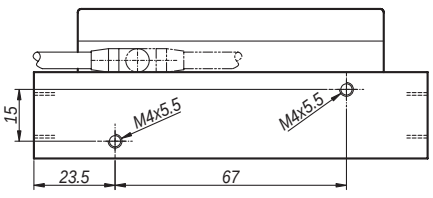


Befestigungsgewinde / Mounting threads / Filets de fixation

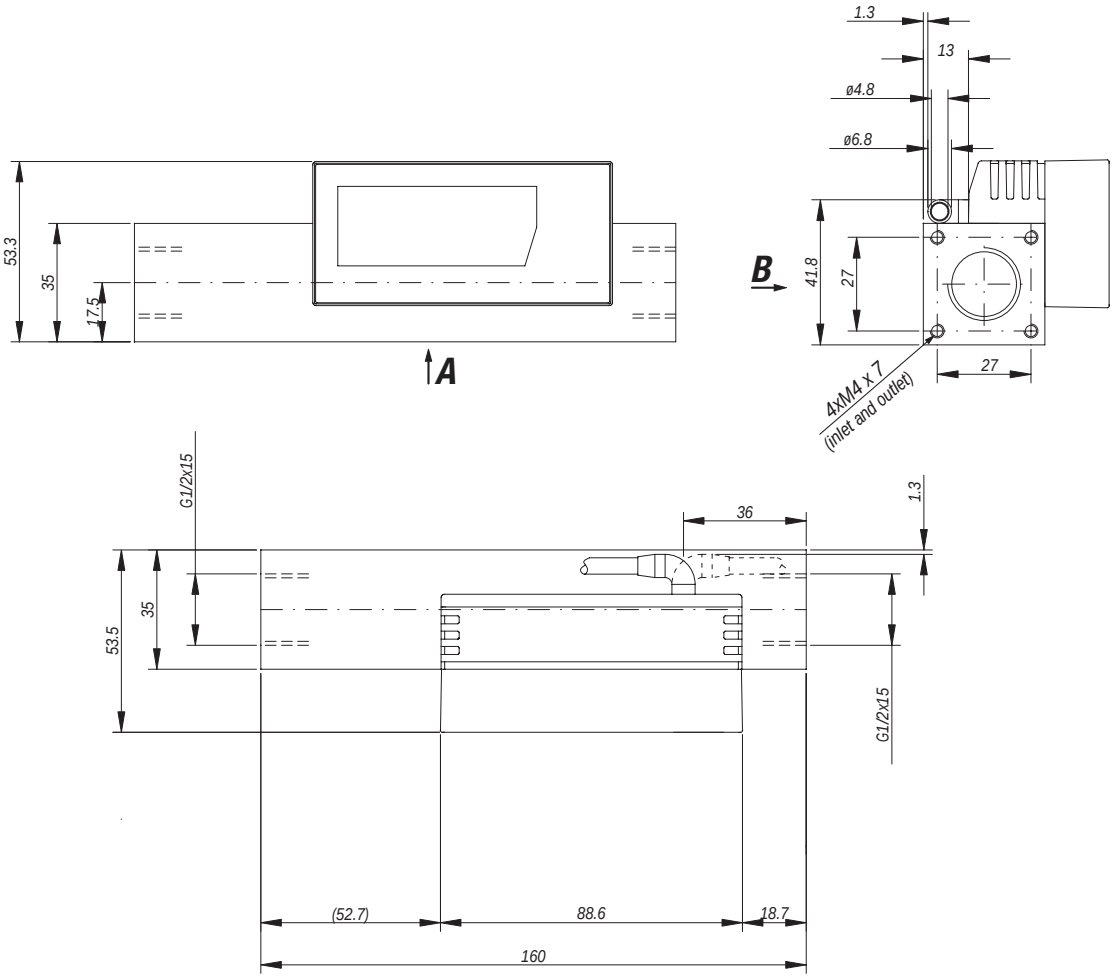
*Ansicht **A** / View **A** / Vue **A***



*Ansicht **B** / View **B** / Vue **B***

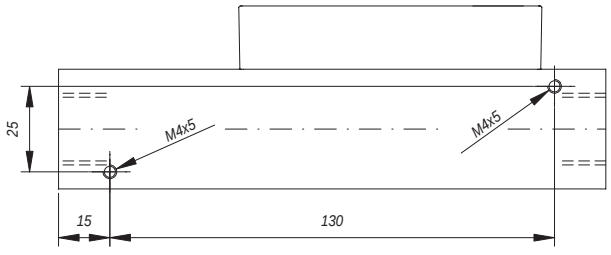


Dimensions G1/2”

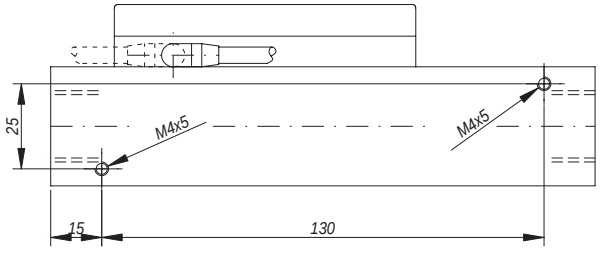


Befestigungsgewinde / Mounting threads / Filets de fixation

*Ansicht **A** / View **A** / Vue **A***



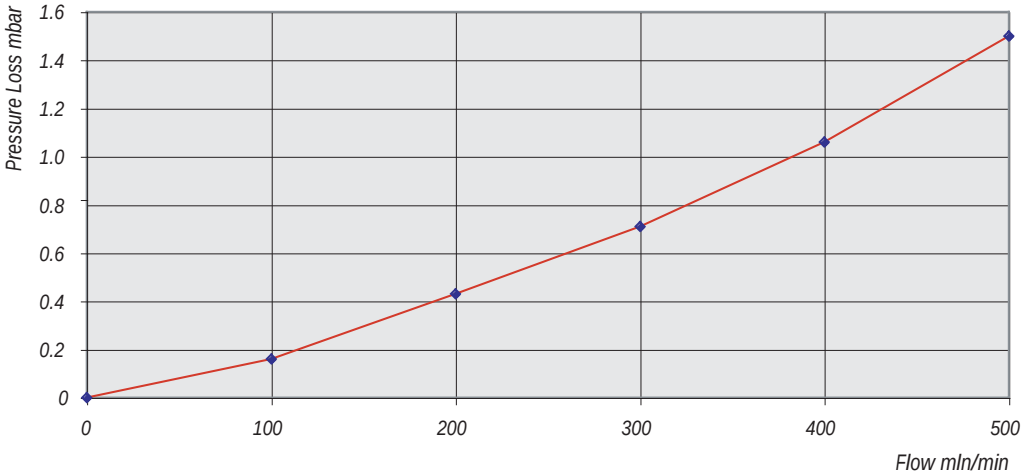
*Ansicht **B** / View **B** / Vue **B***



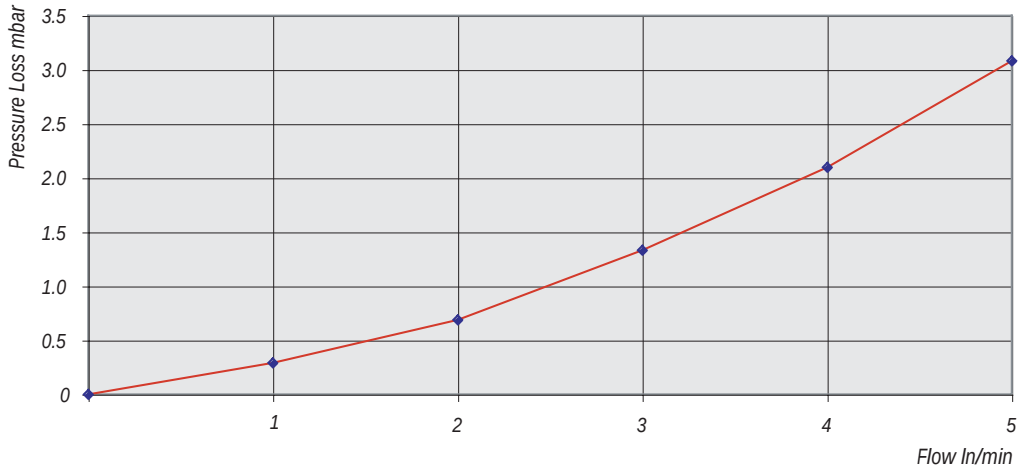
09 Annex

Pressure Loss

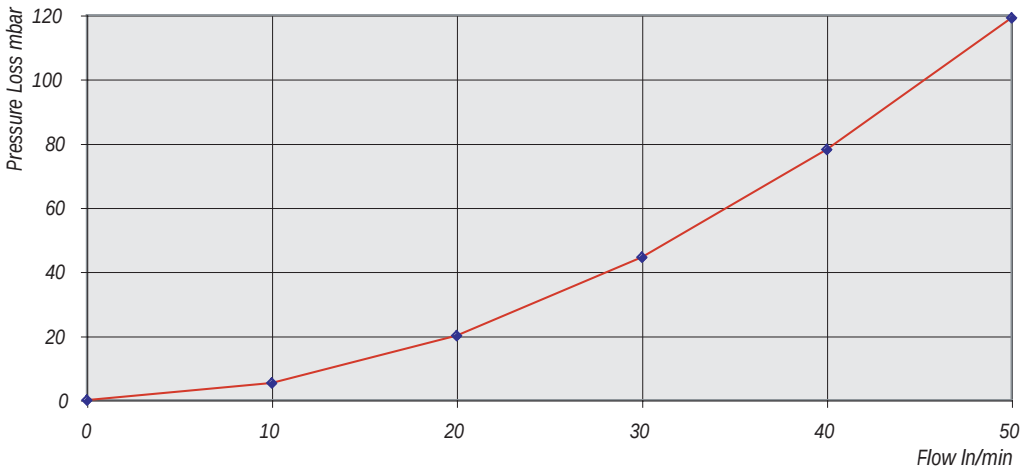
Pressure Loss 500 mln/min (Air)



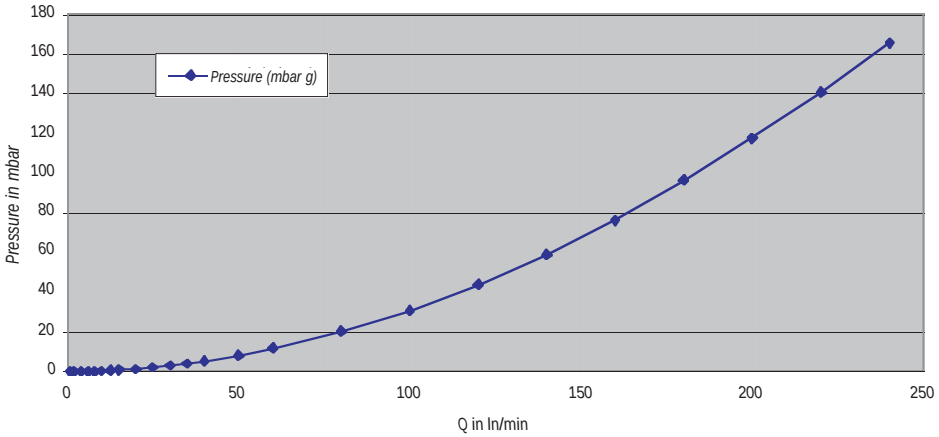
Pressure Loss 5 ln/min (Air)



Pressure Loss 50 ln/min (Air)



Pressure Loss 200ln/min



DB04

Thermal mass flowmeter for gases without auxiliary power

- **Pressure and temperature-independent measurement**
- **Compact design, no need for straight pipe runs**
- **LCD display, flow rate and bar graph**
- **Needle valve, switch output and totaliser as options**
- **High degree of measuring precision**
- **Turndown ratio up to 50:1**
- **Battery operated – no external power supply needed**

Description:

The DB04 thermal mass flowmeter is a modular system for the measurement of the flow of gases. Due to its being independent of any power supply because of its integrated battery, and its excellent cost-effectiveness, the device can replace conventional variable area flowmeters in many cases. The DB04 can be supplied in a number of versions: as a flowmeter with an integrated regulating valve, a totaliser or with an adjustable limit switch. Depending on the medium, the device can be made of either stainless steel or aluminium.

The DB04 measures flows of 4…200 Nml/min up to 4…200 Nl/min. The standard calibration medium is air, but a number of other gases such as O2, N2, He, Ar etc can be measured. A 4-digit LCD display combined with a bar graph display allows the measurements to be read off simply and quickly. The device operates in any position and can be easily cleaned without the need for recalibration.

PKP Process Instruments Inc.
10 Brent Drive · Hudson, MA 01749
+1-978-212-0006 · +1-978-568-0060
Email: info@pkp.eu · Internet: www.pkp.eu

PKP Prozessmesstechnik GmbH
Borsigstraße 24 · D-65205 Wiesbaden
+49 (0) 6122-7055-0 · +49 (0) 6122-7055-50
Email: info@pkp.de · Internet: www.pkp.de

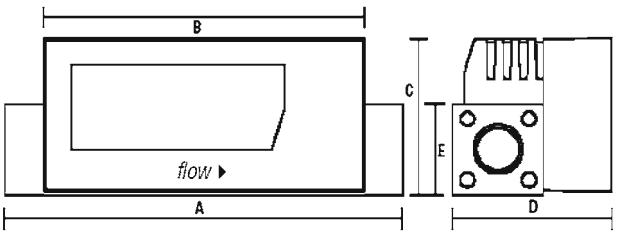
1/08

Versions:

DB04.1: Mass flowmeter (battery-operated)
DB04.2: Mass flowmeter (battery-operated) with integrated manual regulating valve
DB04.3: Mass flowmeter (24V DC externally supplied) with integrated limit switch
DB04.4: Mass flowmeter (24V DC externally supplied) with manual regulating valve and limit switch

Measuring ranges and dimensions:

Measuring-range (NL/min)	Con-nection (G IG)	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)
0,004...0,2	1/4	114	89	44	44	25
0,01...0,5	1/4	114	89	44	44	25
0,04...2	1/4	114	89	44	44	25
0,1...5	1/4	114	89	44	44	25
0,4...20	1/4	114	89	44	44	25
1...50	1/4	114	89	44	44	25
2...100	1/2	160	89	54	54	35
4...200	1/2	160	89	54	54	35



Materials:

DB04.x.x.A: Aluminium casing, PBT sensor, Viton seal
DB04.x.x.E: Special steel casing, electropolished, PBT sensor, Viton seal

Options:

- Totaliser
- EDPM seals
- 24 V DC supply for DB04.1 and 2
- Calibration protocol
- Medium air, N2, O2
- Other media

Ordering Code:

Order no.:	DB04.	1.	01.	A.	0.	L

Thermal mass flowmeter for gases

Version:
1 = Flowmeter
2 = Flowmeter with manual regulating valve
3 = Flowmeter and switch
4 = Flowmeter and switch with manual regulating valve

Measuring range (air):
01 = 0.004 … 0.2 Nl/min
02 = 0.01… 0.5 Nl/min
03 = 0.04 .. 2 Nl/min
04 = 0.1.. 5 Nl/min
05 = 0.4…20 Nl/min
06 = 1…50 Nl/min
07 = 2… 100 Nl/min
08 = 4 …200 Nl/min

Material:
A = Aluminium casing
E = Stainless steel casing

Options:
0 = without
E = EPDM seals
V = Voltage supply 24V DC for DB04.1/2
K = Calibration protocol

Medium:
L = Standard medium: air
N = Standard medium: N2
O = Standard medium O2
S = Other media (please indicate in block letters)

Technical data:

Max. pressure:	10 bars
Medium temperature:	0…50 °C
Measurement uncertainty:	+/- 1% f.s.d.
Response time:	500 ms
Voltage supply:	Lithium battery type AA (service life approx. 2 years) or 24V DC +/- 10%
Display:	LCD, 4-digit
Installation position:	up to 5 bars: any position, over 5 bars: horizontal
Limit value output:	Potential-free change-over contact (24 V, 1 A)
Function:	MIN or MAX alarm, switching point, delay, hy-steresis programmable

PKP Prozessmesstechnik GmbH
Borsigstraße 24 · D-65205 Wiesbaden
+49 (0) 6122-7055-0 · +49 (0) 6122-7055-50
Email: info@pkp.de · Internet: www.pkp.de

PKP Process Instruments Inc.
10 Brent Drive · Hudson, MA 01749
+1-978-212-0006 · +1-978-568-0060
Email: info@pkp.eu · Internet: www.pkp.eu